

Remote Streaming & Visualization of ECCO Data with Jupyter Notebook and IDX

Nina McCurdy/NASA Ames

but first!...

<https://data.nas.nasa.gov/viz/vizdata/llc4320/>

Visualizations of the ECCO Project's 1/48° MITgcm Simulation (aka llc4320)

This page provides access to precomputed visualizations of the Estimating the Circulation and Climate of the Ocean (ECCO, <https://ecco-group.org>) Project's 1/48° Massachusetts Institute of Technology general circulation model (MITgcm, <https://mitgcm.org>) simulation, a 14-month global simulation of the ocean (September 2011 to November 2012) that resolves internal tides and admits submesoscale and internal-gravity-wave variability.

The visualizations make accessible nearly all of the output from the simulation: all scalars, all levels, and all regions. A number of different resolutions are available, from single animations that show a global view to regional closeups that are nearly the same resolution as the simulation.

The different resolutions are organized into five series of animations. Three series show most of the globe, and two show the Arctic. The highest resolution series showing the globe has 128 different views organized into 8 rows and 16 columns. The medium resolution global series has 8 views that roughly divide the domain into eighths, and is organized into two rows each having 4 columns. The lowest resolution global series has a single global view. The high resolution Arctic series has 26 views organized into 6 rows and 5 columns (four views are blank), and the low resolution Arctic series has a single view.

Each series of views has visualizations available in two or three different animation resolution sizes, ranging from about 800 by 600 to sizes that only fit on a 4K monitor. Finally, the animations are available with different time steps, ranging from one hour time steps to one day time steps.

For more information about using this page, the ECCO group has a [web page with detailed instructions](#).

Use the menus below to select the animation series, scalar value, and simulation level (depth). A scalar must be selected before the Level menu is populated as the number of available levels vary by scalar. Selecting a 2D scalar automatically selects the single available level. Once the three selections are made, an image map appears below that shows thumbnails of each available view. Clicking on a thumbnail will open a new tab with a page that has links to animations for the available resolutions and time steps.

Series

128 regions (2-5km)

▼

Scalar

UVspeed (horizontal speed)

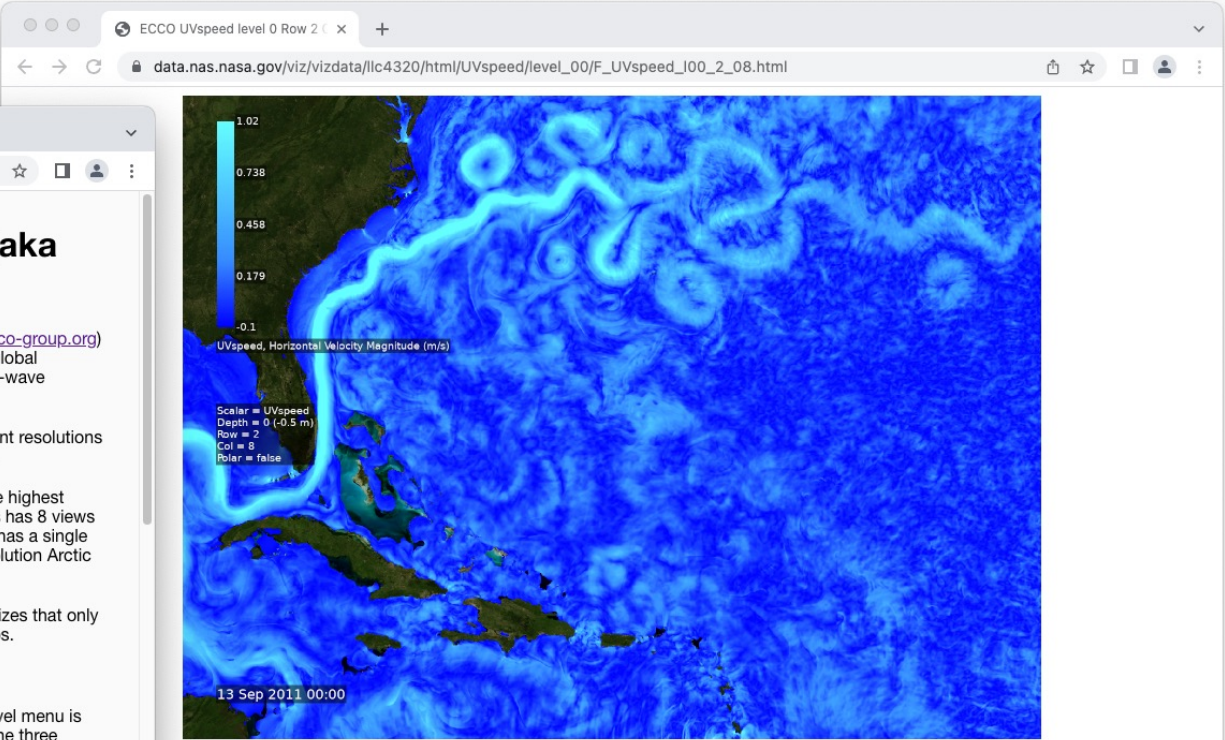
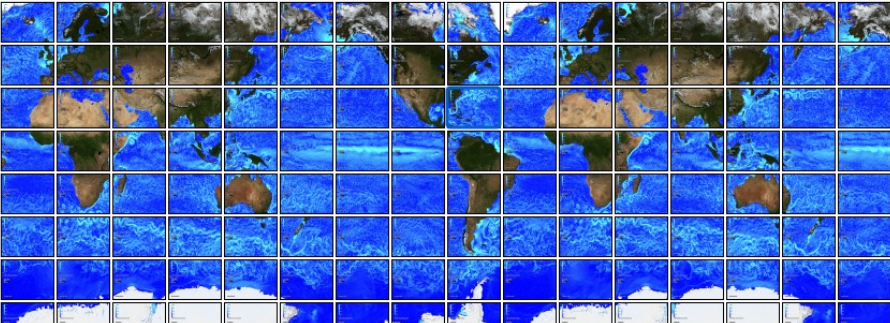
▼

Level

Level 0 (-0.5 m)

▼

Click on one of the 128 images below to see the available animations for UVspeed level 0 at that geographic location in a new tab.



ill select a visualization of UVspeed (horizontal speed) level 0 (depth -0.5 m) located at row 2 column 8 in the 128-region series of animations. The for either a MP4 animation or a full size image. Animations are available for different resolutions and image sizes, and for a range of time steps. The sizes 1.

Timestep	Animation Pixel Resolution and File Size	
	5.4 km / 800x600	2.7 km / 1600x1200
1 hour	587 MB Play MP4 Download MP4 Image	1.5 GB Play MP4 Download MP4 Image
3 hours	251 MB Play MP4 Download MP4 Image	716 MB Play MP4 Download MP4 Image
6 hours	132 MB Play MP4 Download MP4 Image	367 MB Play MP4 Download MP4 Image
12 hours	64 MB Play MP4 Download MP4 Image	183 MB Play MP4 Download MP4 Image
24 hours	34 MB Play MP4 Download MP4 Image	96 MB Play MP4 Download MP4 Image

[Play MP4](#)

<https://data.nas.nasa.gov/viz/vizdata/llc4320/>

Visualizations of the ECCO Proj

data.nas.nasa.gov/viz/vizdata/llc4320/index.html

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Series

Scalar

Level

Series

Scalar

Select scalar first

Note: The menus are sometimes unresponsive when using Safari and returning to this page using the browser Back function. The work-around is to reload the page or to reselect a different value in one of the working menus.

Model output from the 1/48° MITgcm simulation is available at <https://data.nas.nasa.gov/ecco/>. Technical aspects of the visualization are described in Ellsworth et al. (2017). The MITgcm is described in Marshall et al. (1997 a, b). The 1/48° simulation has resulted in more than 80 science publications (see References).

References

Arbic, B. K., Alford, M. H., Ansong, J. K., Buijsman, M. C., Ciotti, R. B., Farrar, J. T., Hallberg, R. W., Henze, C. E., Hill, C. N., Luecke, C. A., Menemenlis, D., Metzger, E. J., Müller, M., Nelson, A. D., Nelson, B. C., Ngodock, H. E., Ponte, R. M., Richman, J. G., Savage, A. C., ... Zhao, Z. (2018). A Primer on Global Internal Tide and Internal Gravity Wave Continuum Modeling in HYCOM and MITgcm. In E. P. Chassignet, A. Pascual, J. Tintoré, & J. Verron (Eds.), *New Frontiers in Operational Oceanography* (pp. 30–392). GODAE OceanView <https://doi.org/10.17125/gov2018.ch13>

Ardhuin, F., Aksenov, Y., Benetazzo, A., Bertino, L., Brandt, P., Caubet, E., Chapron, B., Collard, F., Cravatte, S., Delouis, J. M., Dias, F., Dibarbouré, G., Gaultier, L., Johannessen, J., Korosov, A., Manucharyan, G., Menemenlis, D., Menendez, M., Monnier, G., ... Xie, J. (2018). Measuring currents, ice drift, and waves from space: The Sea surface Kinematics Multiscale monitoring (SKIM) concept. *Ocean Sci.*, 14(3), 337–354. <https://doi.org/10.5194/os-14-337-2018>

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https://data.nas.nasa.gov/viz/vizdata/DYAMOND_c1440_llc2160/MITgcm/

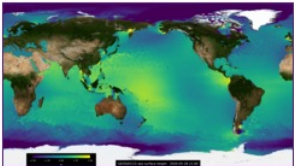
2021 GEOS5 / MITgcm Coupled Simulation
(c1440_llc2160)

MITgcm Fields

Show GEOS Fields

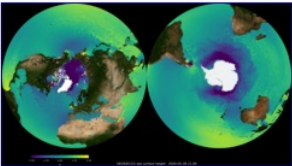
HD MP4 Directory Listing 4K MP4 Directory Listing Images Directory Listing

Eta – lat-lon
sea surface height



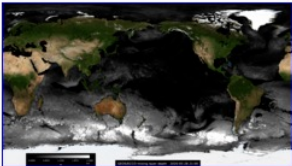
HD MP4 4K MP4 4K Image

Eta – polar
sea surface height



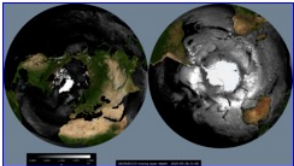
HD MP4 4K MP4 4K Image

KPPhbl – lat-lon
mixing layer depth



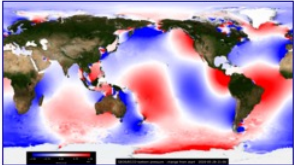
HD MP4 4K MP4 4K Image

KPPhbl – polar
mixing layer depth



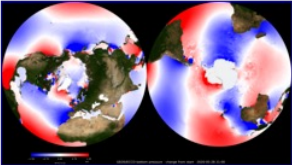
HD MP4 4K MP4 4K Image

PhiBot – lat-lon
bottom pressure - change from start



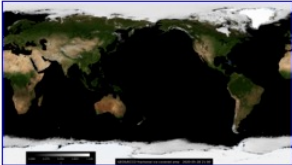
HD MP4 4K MP4 4K Image

PhiBot – polar
bottom pressure - change from start



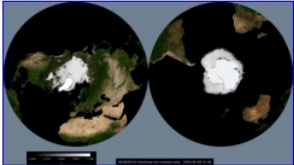
HD MP4 4K MP4 4K Image

Slarea – lat-lon
fractional ice-covered area



HD MP4 4K MP4 4K Image

Slarea – polar
fractional ice-covered area



HD MP4 4K MP4 4K Image

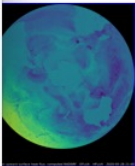
2021 GEOS5 / MITgcm Coupled Simulation
(c1440_llc2160)

GEOS Fields

Show MITgcm Fields

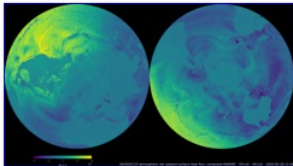
listing 4K MP4 Directory Listing Images Directory Listing

atmQflux-15mn – lat-lon
atmosphere net upward surface heat flux; computed RADSRF - EFLUX - HFLUX



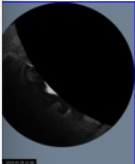
4K Image

atmQflux-15mn – polar
atmosphere net upward surface heat flux; computed RADSRF - EFLUX - HFLUX



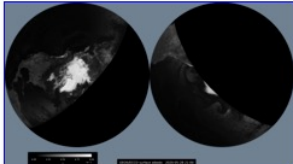
HD MP4 4K MP4 4K Image

ALBEDO-15mn – lat-lon
surface albedo




4K Image

ALBEDO-15mn – polar
surface albedo




HD MP4 4K MP4 4K Image

near infrared
surface albedo for near infrared beam



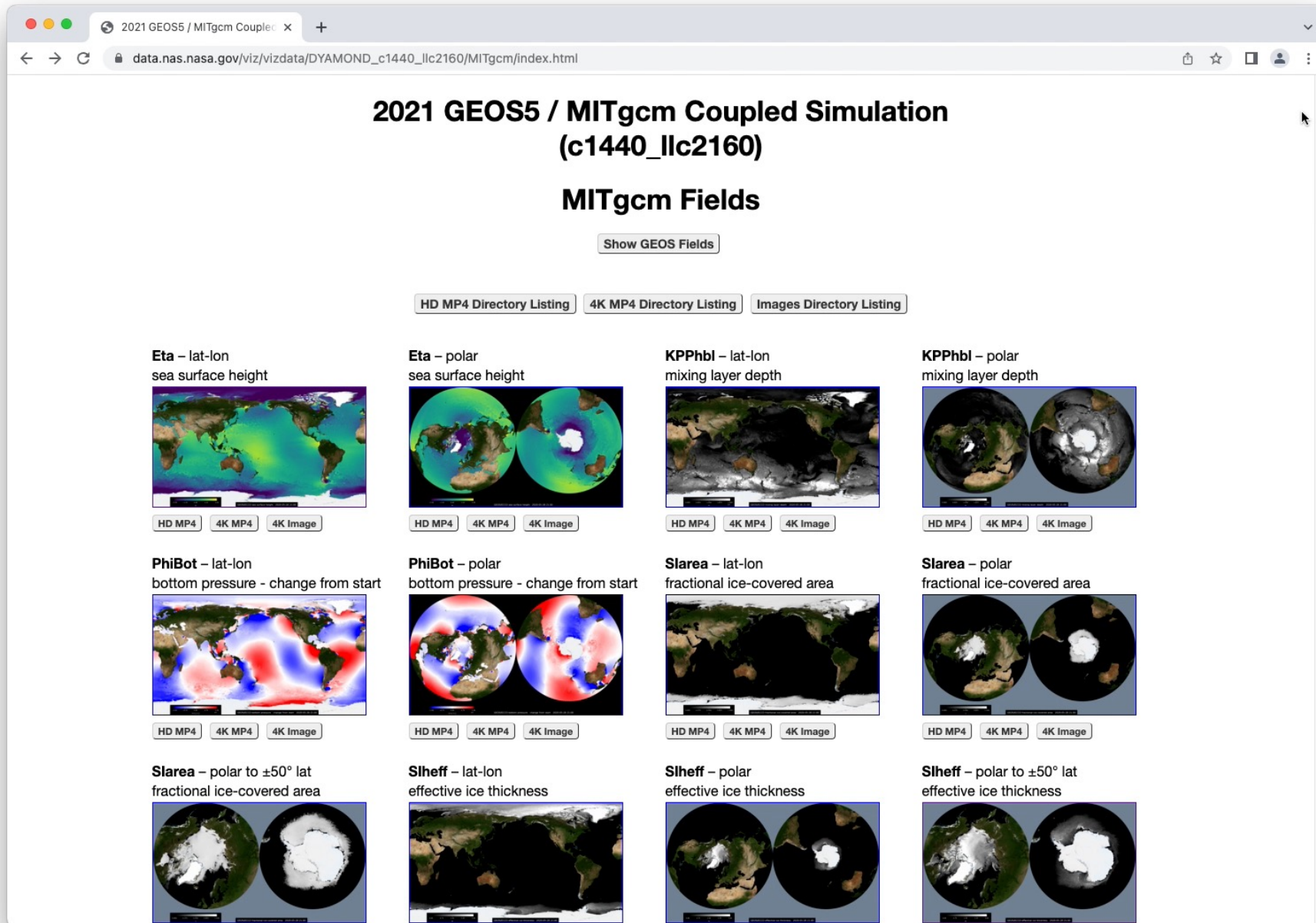
4K Image

near infrared
surface albedo for near infrared beam



HD MP4 4K MP4 4K Image

https://data.nas.nasa.gov/viz/vizdata/DYAMOND_c1440_llc2160/MITgcm/



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MITgcm compressed data extraction tool

usage: extract[4320,2160] [options] timesteps fieldNames 3DstartPoint 3Dextent

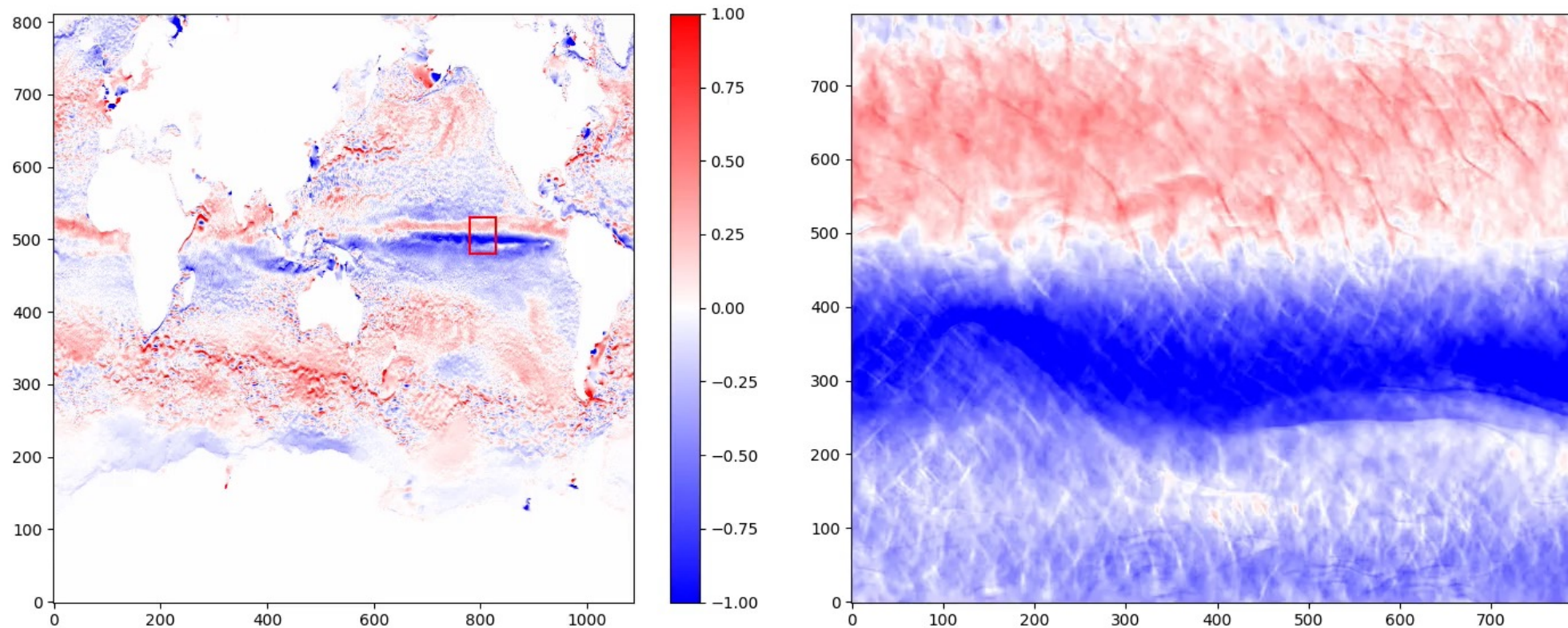
MITgcm "uncompress" tool

usage: uncompress[4320,2160] [options] timesteps fieldNames

Remote streaming and Visualization with Jupyter Notebook and IDX(2)

- **IDX(2)** : wavelet compression + octree data structure to support progressive decompression of data at different levels of precision and resolution
- **Jupyter Notebooks at NAS** : to support remote streaming and interactive visualization of IDX(2)-formatted data.

Figure 1



x=555. y=759. [0.000]



llc4320_time... (4) - JupyterLab ×Bokeh Application

← → ↺

https://localhost:8080/lab/tree/NASA/llc4320_time_autorun.ipynb

📄 ☆

☰

FileEditViewRunKernelTabsSettingsHelp

+

📁

📄

🔄

Filter files by name

🔍

/ NASA /

Name	Last Modified
📁 c1440_llc2...	an hour ago
📁 Atmospher...	2 hours ago
📁 llc4320_s...	an hour ago
📁 llc4320_ti...	8 minutes ago
📁 llc4320_v...	an hour ago
📁 llc4320_v...	an hour ago
📁 nas_demo...	3 hours ago
📁 NASA_de...	an hour ago

llc4320_select_time_depth ×llc4320_time_autorun.ipynl ×llc4320_vorticity.ipynb ×NASA_demo.ipynb ×

📄 + ✂ 📄 📄 ▶ ⏏ ↺ ⏏ Code ▾

Python 3 (ipykernel) ⌵

1600

1400

1200

1000

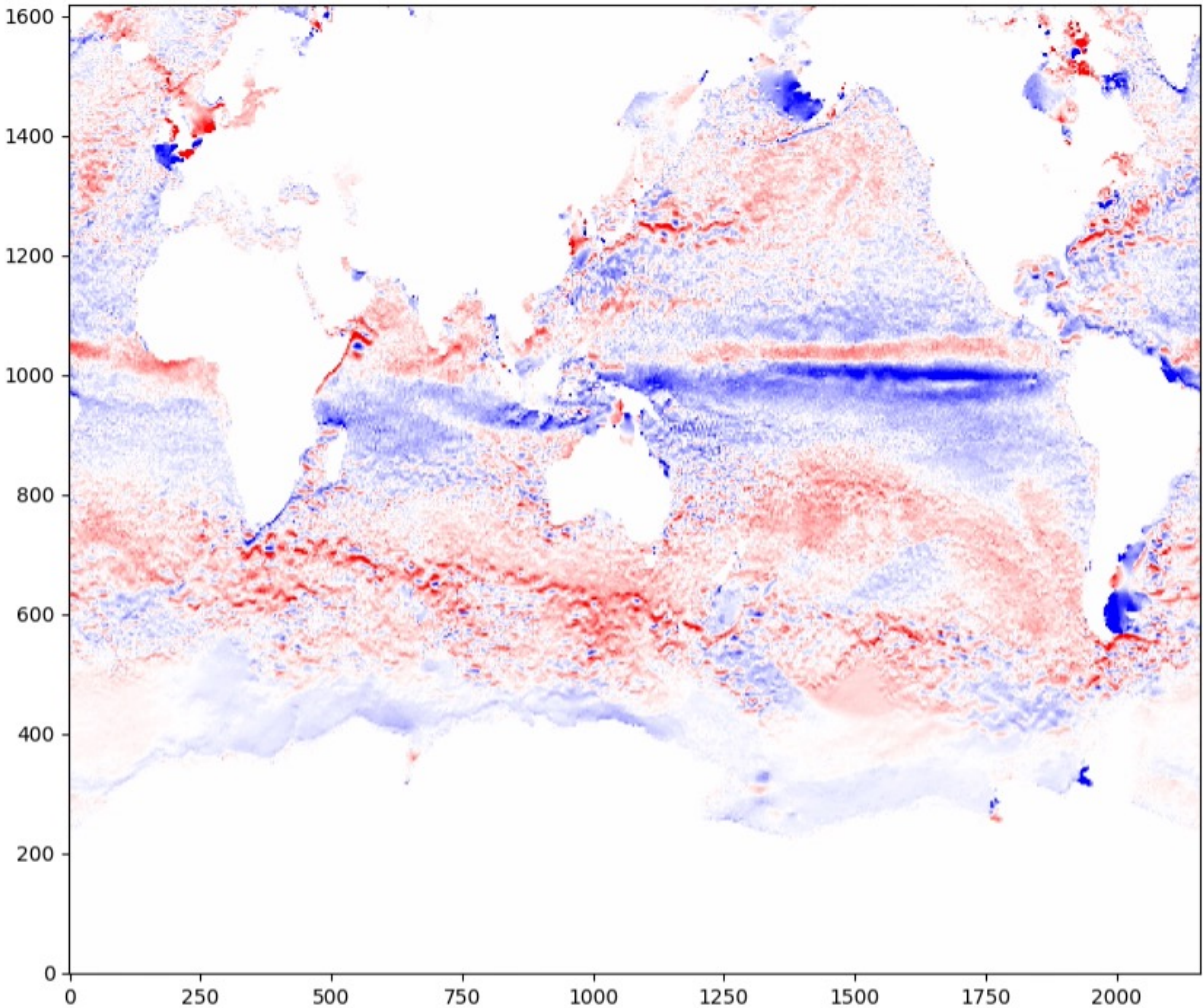
800

600

400

200

0



025050075010001250150017502000

1.00

0.75

0.50

0.25

0.00

-0.25

-0.50

-0.75

-1.00

Simple 0 8 Python 3 (ipykernel) | Idle

Mode: CommandLn 1, Col 1llc4320_time_autorun.ipynb

OpenVISUS streaming analysis of data from NAS server: 'DYAMOND c1440 llc2160, atmospheric data: U (eastward wind velocity)

size of visualization panel below: 616

N-S: 367

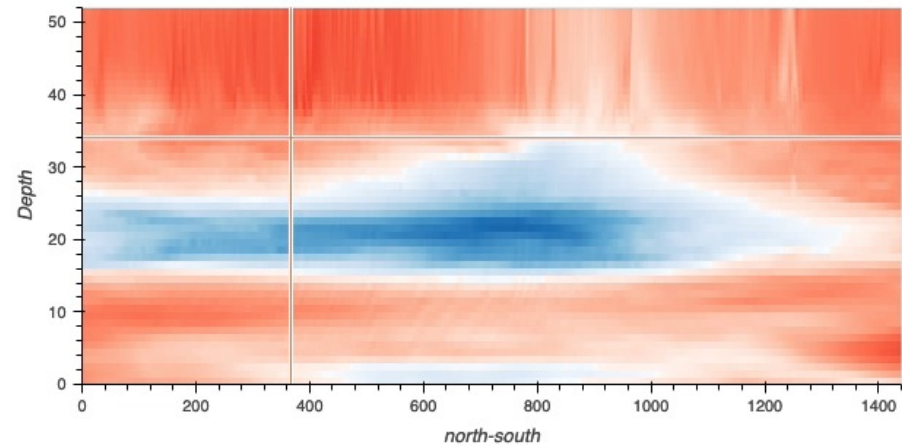
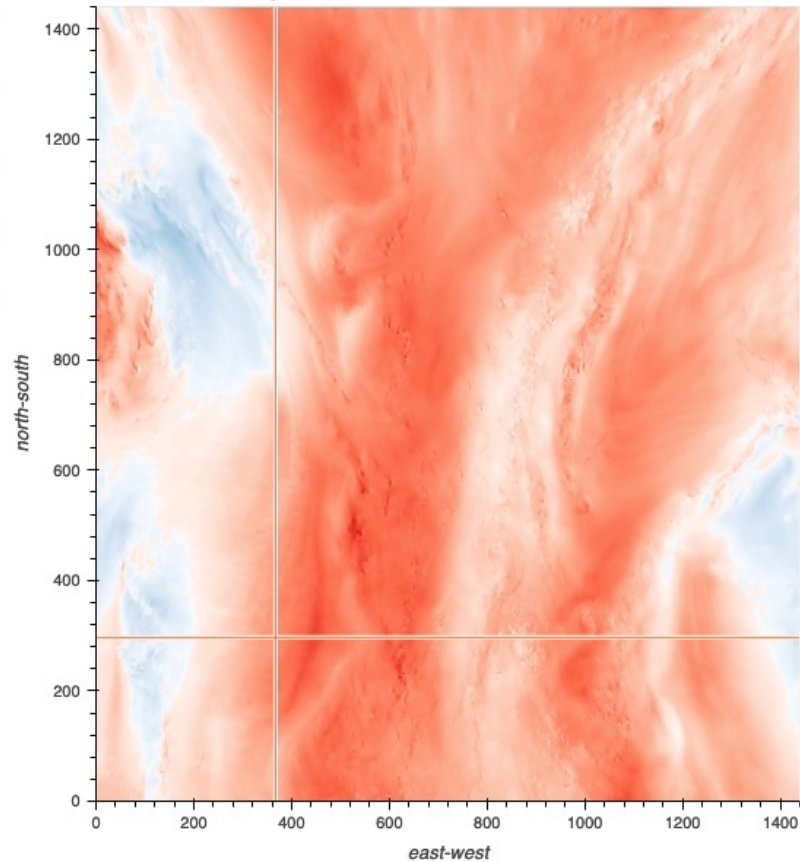
E-W: 297

Depth: 34

Time: 1

Zone: 3

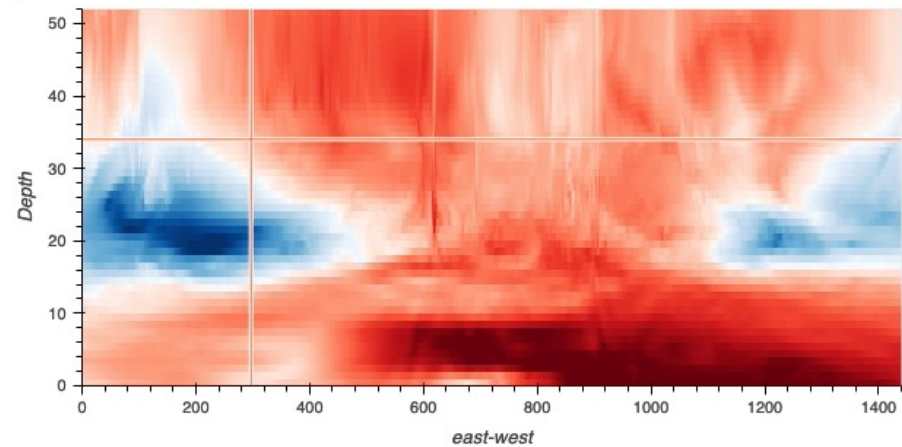
Select direction, depth, time, and zone



▶ Play

▶ Play slow

Timestep: 1



▶ Play

▶ Play slow

Thank you!
Questions?

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https://data.nas.nasa.gov/viz/vizdata/DYAMOND_c1440_llc2160/MITgcm/

<https://data.nas.nasa.gov/viz/vizdata/llc4320/>